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FILING DATE: *September 03, 2002*
RELATED PCT APPLICATION NUMBER: *PCT/US03/27392*

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53 (c).

Express Mail Label No. EV 104020516 US

jc968 U.S. PTO
09/04/02

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☐ *Additional Inventors are being named on the _____ separately numbered sheets attached hereto*

TITLE OF THE INVENTION (280 characters max)

A QOS MECHANISM FOR LAN THAT INCLUDES PRIORITY AND RESERVED BANDWIDTH SERVICES

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☒ Specification *Number of Pages* 20 ☐ CD(s), Number [ ]

☐ Drawing(s) *Number of Sheets* [ ] ☐ Other (specify) [ ]

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT *(check one)*

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fees

FILING FEE AMOUNT ($)

☒ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 07-0832 — 160

☐ Payment by credit card. Form PTO-2038 is attached.

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____.

Respectfully submitted,

SIGNATURE [signature] Date 9/3/02

TYPED or PRINTED NAME PAUL P. KIEL REGISTRATION NO. *(if appropriate)* 40,677

TELEPHONE 609 734 6815 Docket Number: PU020417

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

This collection of information is required by 37 CFR 1 51 The information is used by the public to file (and by the PTO to process) a provisional application Confidentiality is governed by 35 U S C 122 and 37 CFR 1 14 This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the complete provisional application to the PTO Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U S Patent and Trademark Office, U S Department of Commerce,

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PU020417

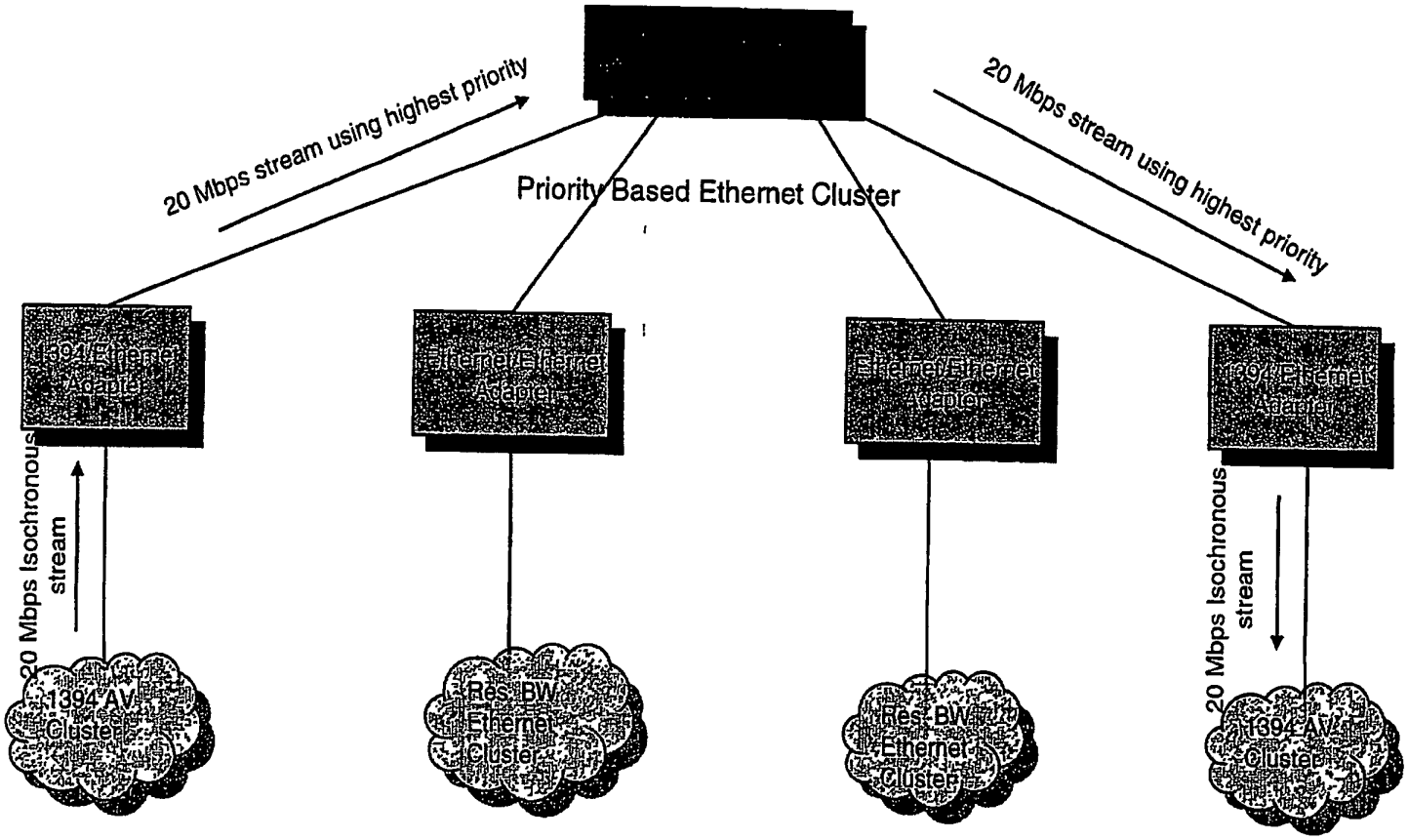
A QOS Mechanism for LAN that Includes Priority and Reserved Bandwidth Services

Why do we need to determine an Ethernet QOS mechanism?

- Historically Ethernet is only best effort.
  - Guaranteed delivery assured by TCP, but this is achieved through retransmissions. Therefore, packet delivery time is not assured.
- AV Services generally require high QOS (i.e., no dropped packet and packet delivered on time).

- We need to determine Ethernet QOS mechanisms to assure that AV service packets generated on the Ethernet or Internet are delivered in a timely manner.
  - For native Ethernet/IP traffic and traffic from the Internet, priority based schemes are a popular approach partially because of their simplicity.
- We also need to determine an Ethernet QOS mechanism so that the R7.5 1394/Ethernet Adapter architecture can be completed.
  - Since 1394 Isochronous Channels use a BW Reservation mechanism, it is thought by some that a BW Reservation scheme on the Ethernet would result in a reasonable Adapter.

A Proposed QOS Architecture

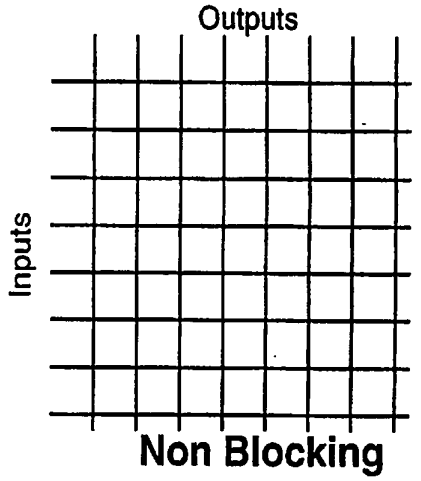


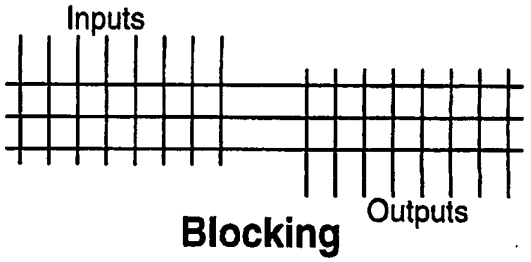
QOS Proposal based on the Proposed Architecture

- Adapter is responsible for BW reservation and admission control services of network.
- Adapters assume the use of a VLAN (802.1q) non-blocking switch when R7.4 backbone is Ethernet only.
- Adapters use a BW Reservation that is similar to ch 4 of 1394.1 bridge specification.
- Talker Adapter and Listener Adapter communicate and negotiate Reserved BW.
- All Adapters have an Avail_BW register and Total_BW register.
- During connection stage, listener checks its Avail_BW register against the requirements of the stream. If there is enough BW, the Adapter reduces the Avail_BW register by that amount. The talker then does the same thing with its Adapter. Both Adapters must communicate to establish BW requirements and to inform the other side if BW was allocated.

Blocking vs Non Blocking Switches

- An ideal switch is non-blocking.
  - Non-blocking means that any input can get to any output independent of the state of the other inputs and outputs
- Many practical switches block.
  - A switch is a blocking switch if it is possible for the state of other inputs/outputs to affect whether a connection can be made from an input to an output. If the switch is busy enough, the connection cannot be made. So, a blocking switch is resource limited.
- See analog example to the right. Top switch is non-blocking with 64 individual switches. Bottom switch is blocking with 48 individual switches
- Non-blocking vs. Blocking switches and the extent to which they block is an issue no matter what QOS mechanism is chosen.





Disadvantages of Previous Proposal

- A non-blocking switch was assumed.
- Disruptive to mechanism on VLAN backbone by always using the highest priority, diminishing the value of native devices on the network. Some traffic carried on Isochronous channels of 1394 should not be the highest priority on the Ethernet side.
- Requires an Adapter to be on every link of the Central Ethernet Switch
  - devices tied directly to switch always get a lower priority than 1394 Iso Traffic.
  - Adapter is needed between Ethernet devices and switch to keep them from accidentally overloading switch thereby breaking guaranteed delivery of 1394 Iso Traffic.
- Distinguishes between two types of middle layers over Ethernet, one set for an endpoint cluster, another for the backbone cluster. Normally Ethernet would be one cluster unless bridged through 1394 or some other network technology.

Observations

- Most devices on a home Ethernet can be placed into one of three categories or roles:
  - hub/switch/router
  - Endpoint (servers, clients)
  - Gateways
- Sometimes devices take on multiple roles.
- Adapter can be thought of a specific type of gateway.
- It doesn't seem that gateways should enforce QOS on an Ethernet cluster.
  - The customer may not understand the need for an Adapter to hook their Ethernet based endpoint to an Ethernet switch
  - An ideal switch would be non-blocking, but most practical switches currently block at some load.
  - Seems like Ethernet topology and switch characteristics can affect QOS the most.

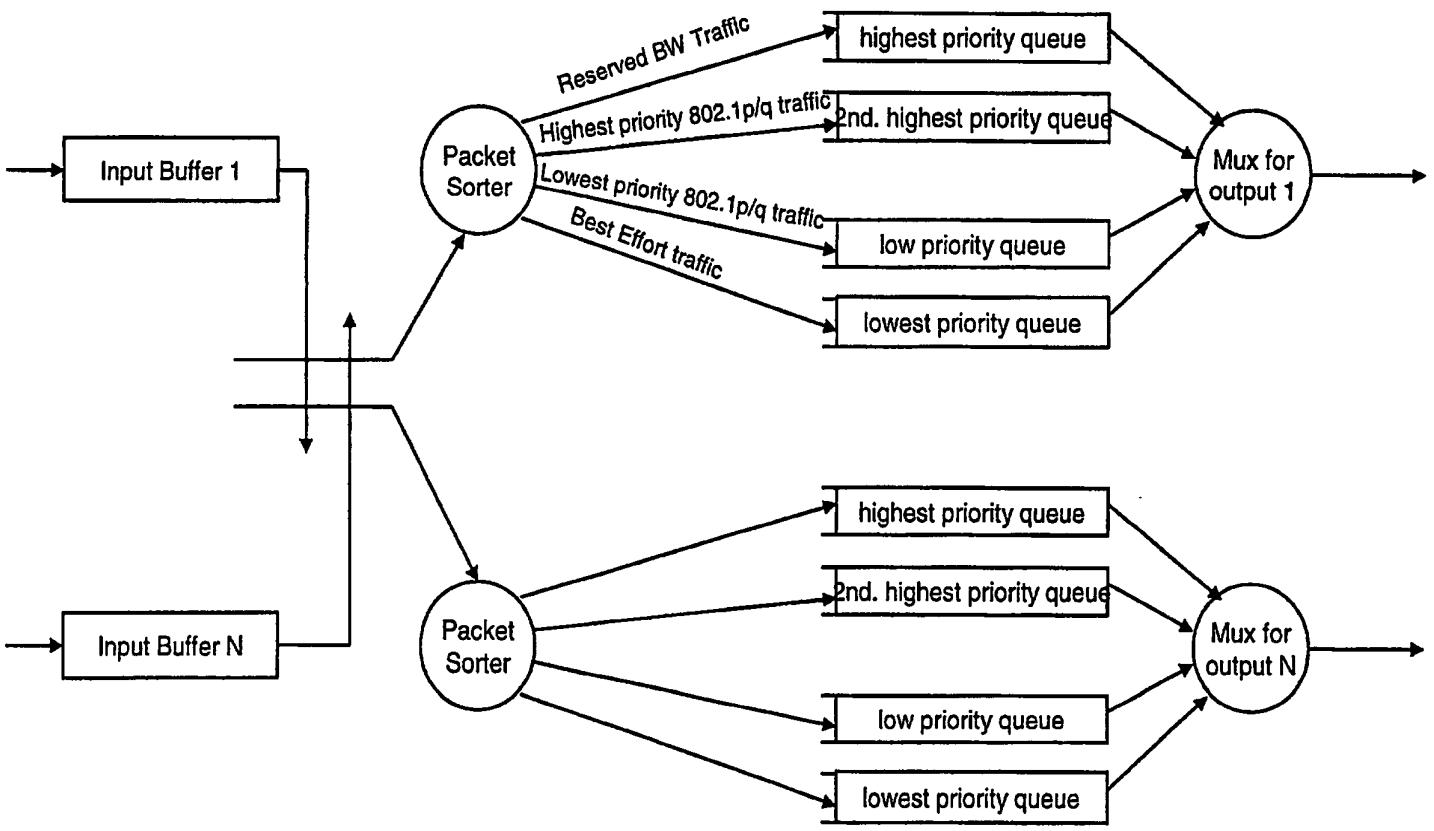
More Observations

- Gateways and Adapters separate clusters from each other and the Internet.
- Ethernet backbone can be considered a cluster and should be allowed to have native devices.
- Customers are already getting used to upgrading their central switch (hub ⇒ switch ⇒ router etc.)
- Bridging 1394 Isochronous channels to a reserved bandwidth channel on Ethernet may have some value.
  - However, reserved bandwidth mechanisms seem more complex than priority based schemes.
  - Therefore, best if reserved BW mechanism were optional for the IP based Ethernet, but may be mandatory for connecting Isochronous channels.
  - Adapter could tunnel 1394 Isochronous traffic through such a channel.

Counter Proposal

- Move BW Reservation functions into switch.
  - This function should be optional, but may be required in cases where the customer wants to bridge Isochronous Channels from one 1394 cluster to another.
- Assume switch is also 802.1p/q.
  - For an 802.1p/q switch, reserved BW traffic can be given the highest priority within the switch.
  - That priority should not be available directly on the LAN outside of the switch.
- No need to standardize the amount of BW used for reservation, blocking, etc.
  - Switch knows what it can do and takes care of itself.
  - As long as packets remain in a higher priority queue, those packets are transmitted before packets in lower priority queues.

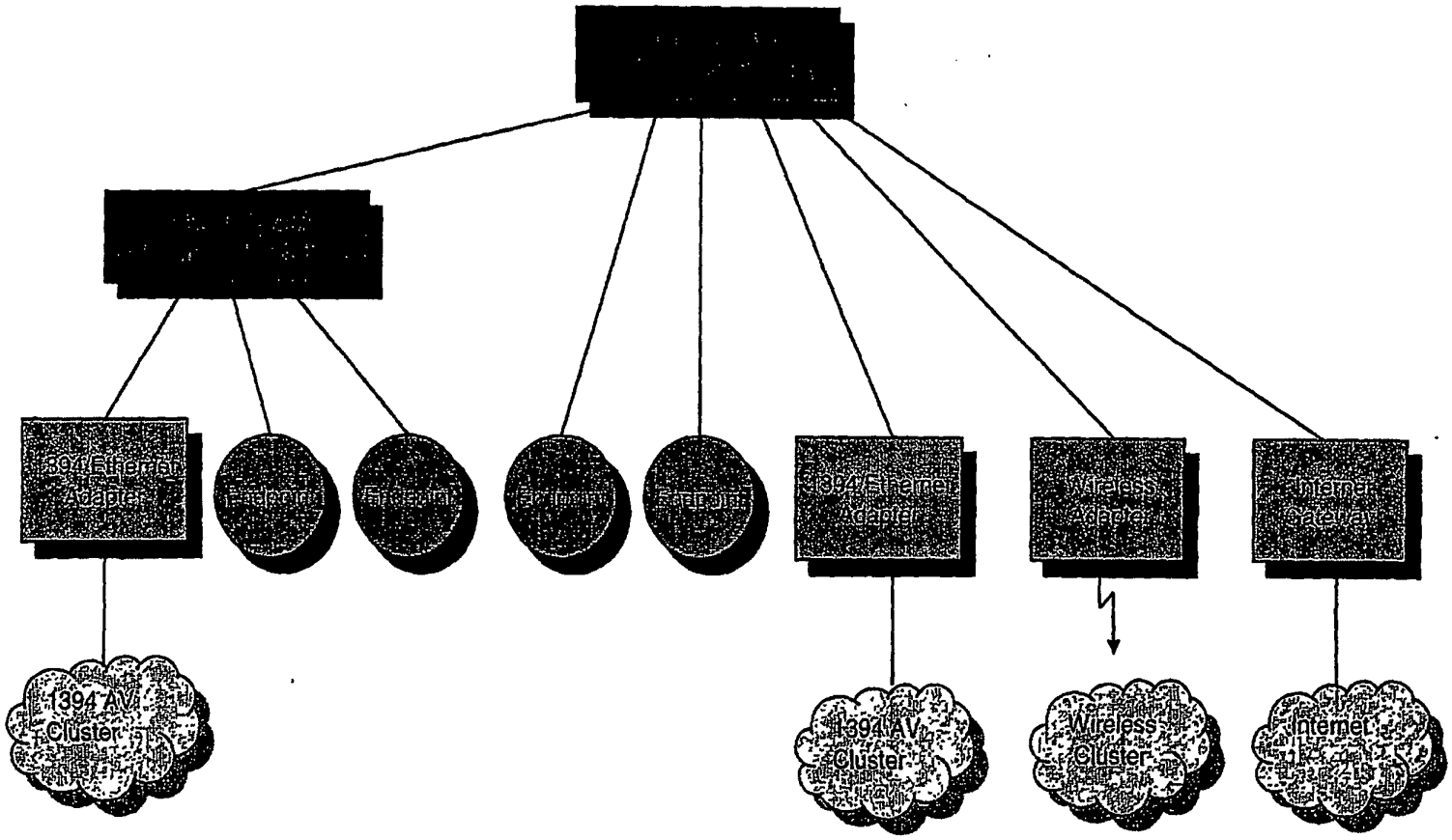
Priority Queues in Switch



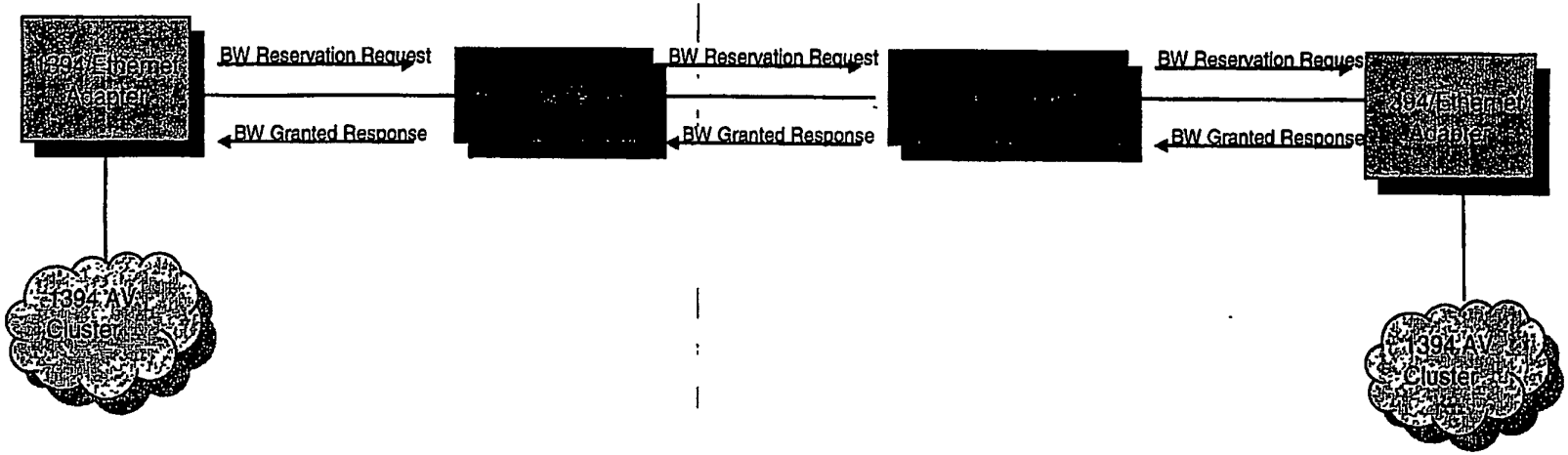
Counter Proposal (continued)

- Reservation BW protocol would be initiated and terminated from Adapters, Gateways, and Ethernet Endpoints. Switches act on messages and forward or respond.
  - Adapter uses common 1394 protocols on 1394 side, and BW reservation for Iso channels on Ethernet side. They represent the 1394 cluster to the rest of the devices on the network perhaps using UPnP. The terminating Adapter regenerates Isochronous timing on 1394.
  - Asyn IP traffic gets bridged to IP on Ethernet side with 802.1p/q priorities properly set.
  - BW Reservation must be periodically refreshed for reservation to continue (e.g., once per minute). This allows connections to be torn down and BW freed up if the stream stops for some reason (e.g., switch in path powered down).
- Don't know exact BW reservation protocols yet. Maybe IntServ???
  - Would be nice if switch didn't evolve to a router, but that may be OK if simple enough.
  - Don't know yet if these switches need IP addresses. If they do, UPnP can maybe be used to discover state, capabilities, etc.

Architecture



Successful BW Reservation



High Level BW Reservation Process

- Endpoint or Adapter (client) sends BW request toward the video server (endpoint) or to far end Adapter.
- Switch intercepts request
  - if it has enough BW , it marks the requested amount as pending and forwards request toward the server.
  - if there is not enough BW, then it sends a BW Denial back to the requesting device.
- End Device (server) process BW request
  - If it can allocate the BW necessary for the video transmission, then it sends a BW Allocated Response.
  - If it can not allocate the necessary BW, then it sends a BW Denial back toward requesting device.
- Switch intercepts responses
  - If the received response is BW Allocated, then allocate BW.
  - If the received response is BW Denied, then free pending BW.

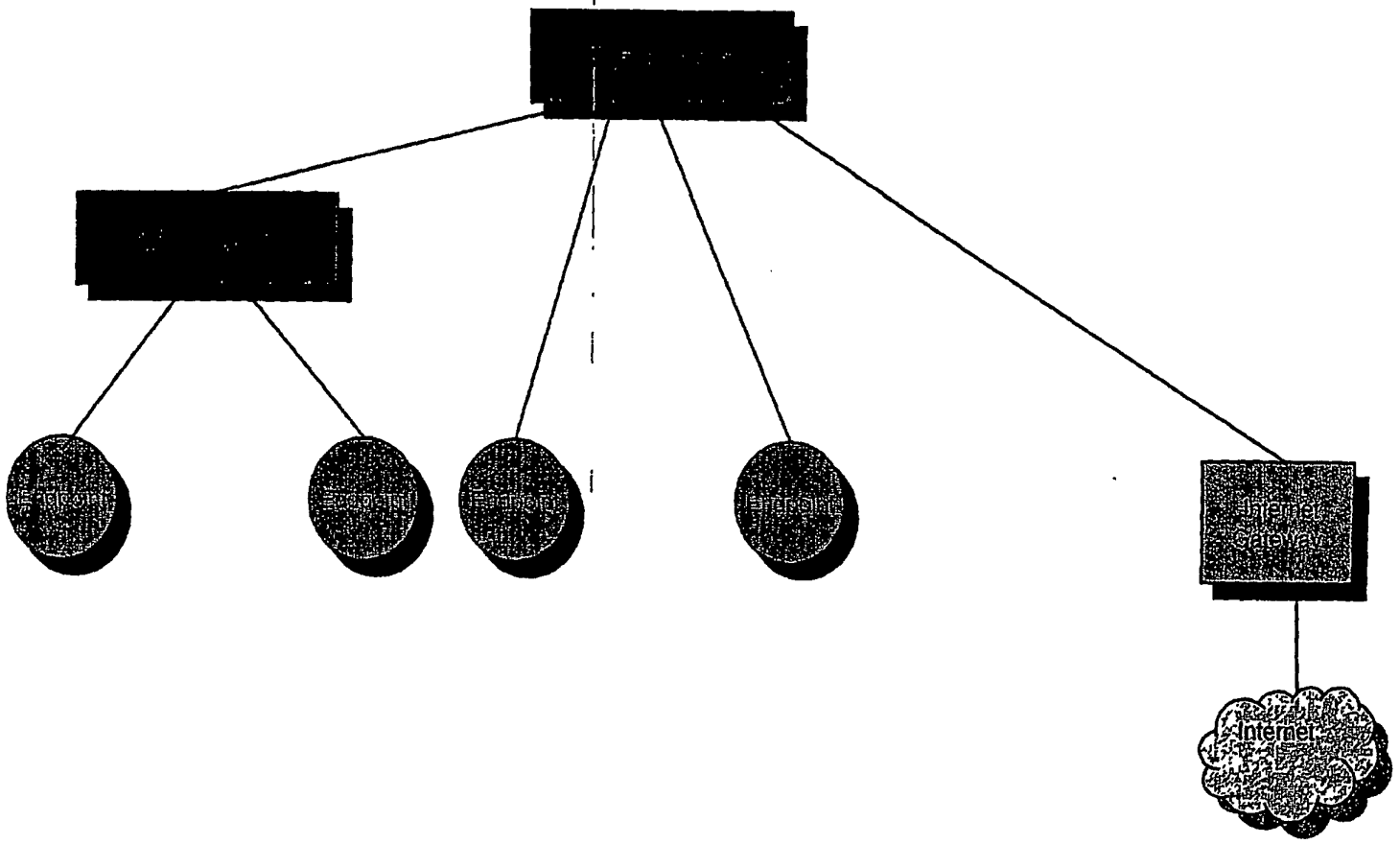
High Level BW Reservation Process (2)

- Client Endpoint should refresh BW request periodically to maintain reservation.
  - If no periodic refresh is received, then BW is released.
  - If request comes within a specified time window, then devices are guaranteed to retain their reserved BW.
- If connection is accidentally shutdown, then client must recognize that (possibly using the lack of RTCP feedback assuming RTP is used) and request BW.
- Switch should maintain/reserve a certain percentage of BW (e.g., 50%) for 802.1p/q traffic and best effort traffic.

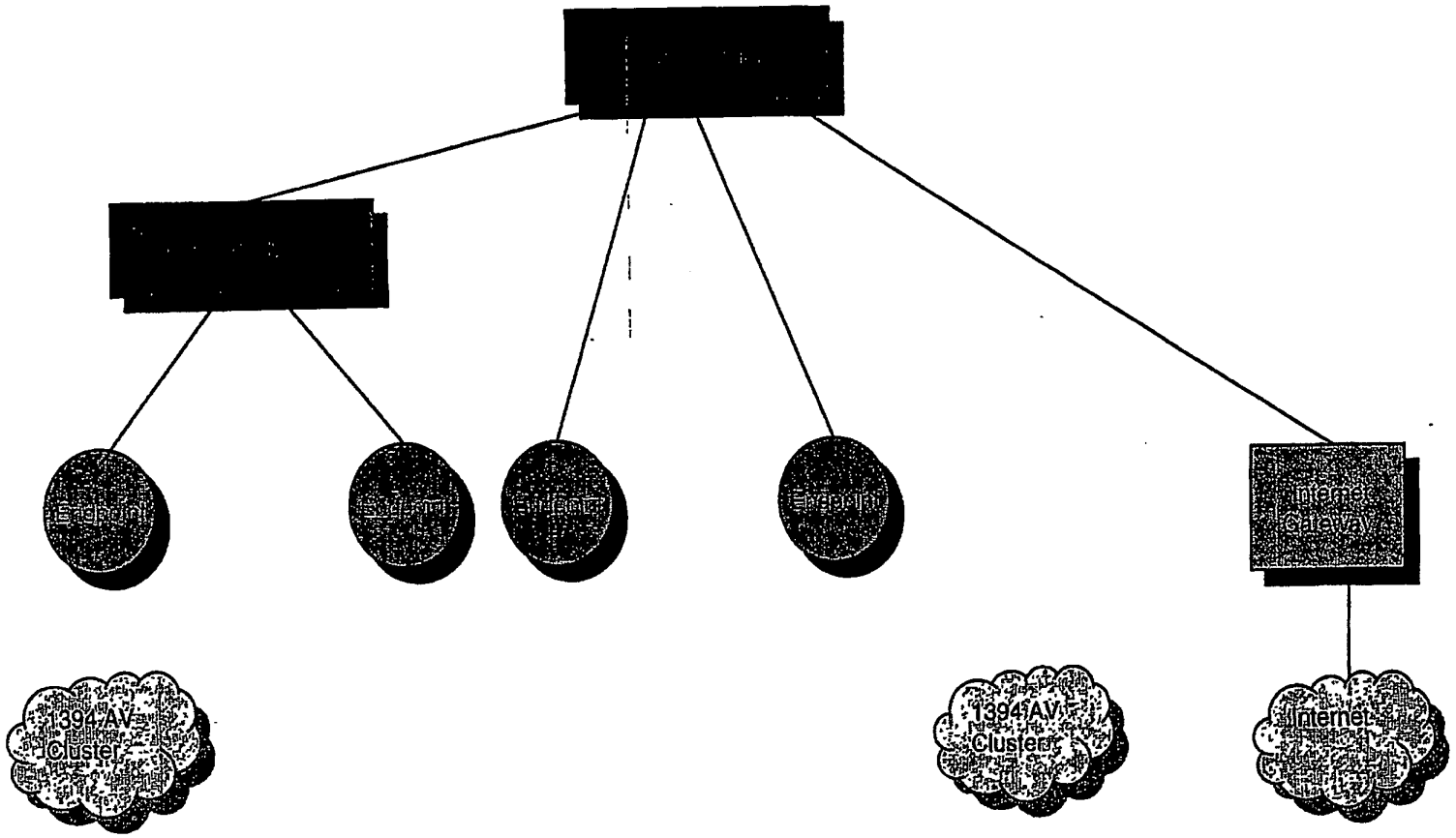
Result

- Priority based QOS mechanisms works and Reserved BW mechanisms work when available.
- No Adapters needed for native Ethernet devices.
- Adapters only needed between 1394 and Ethernet. Possibly also between wireless clusters and either Ethernet or 1394b.

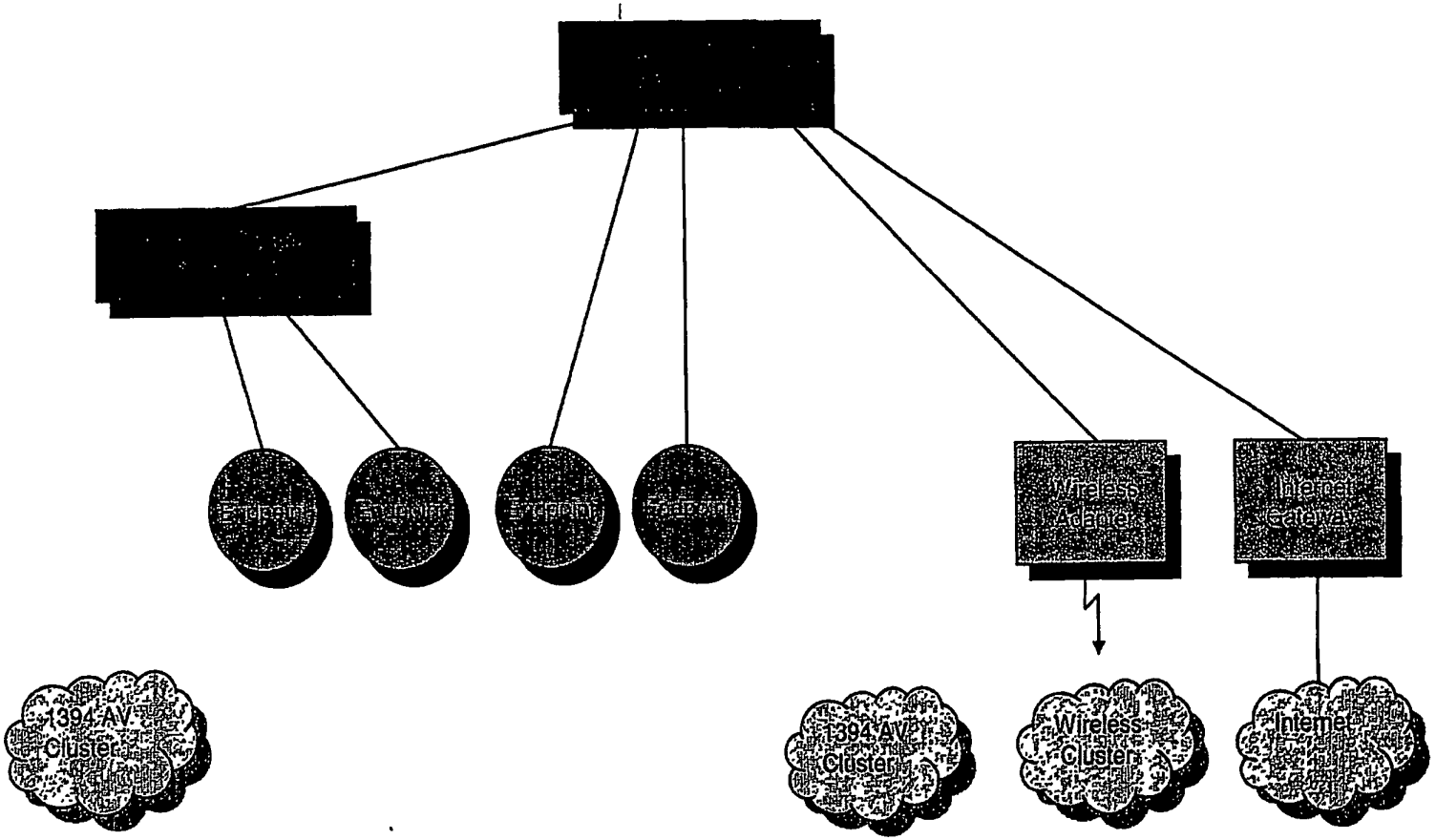
Example of Customer Upgrade (1)



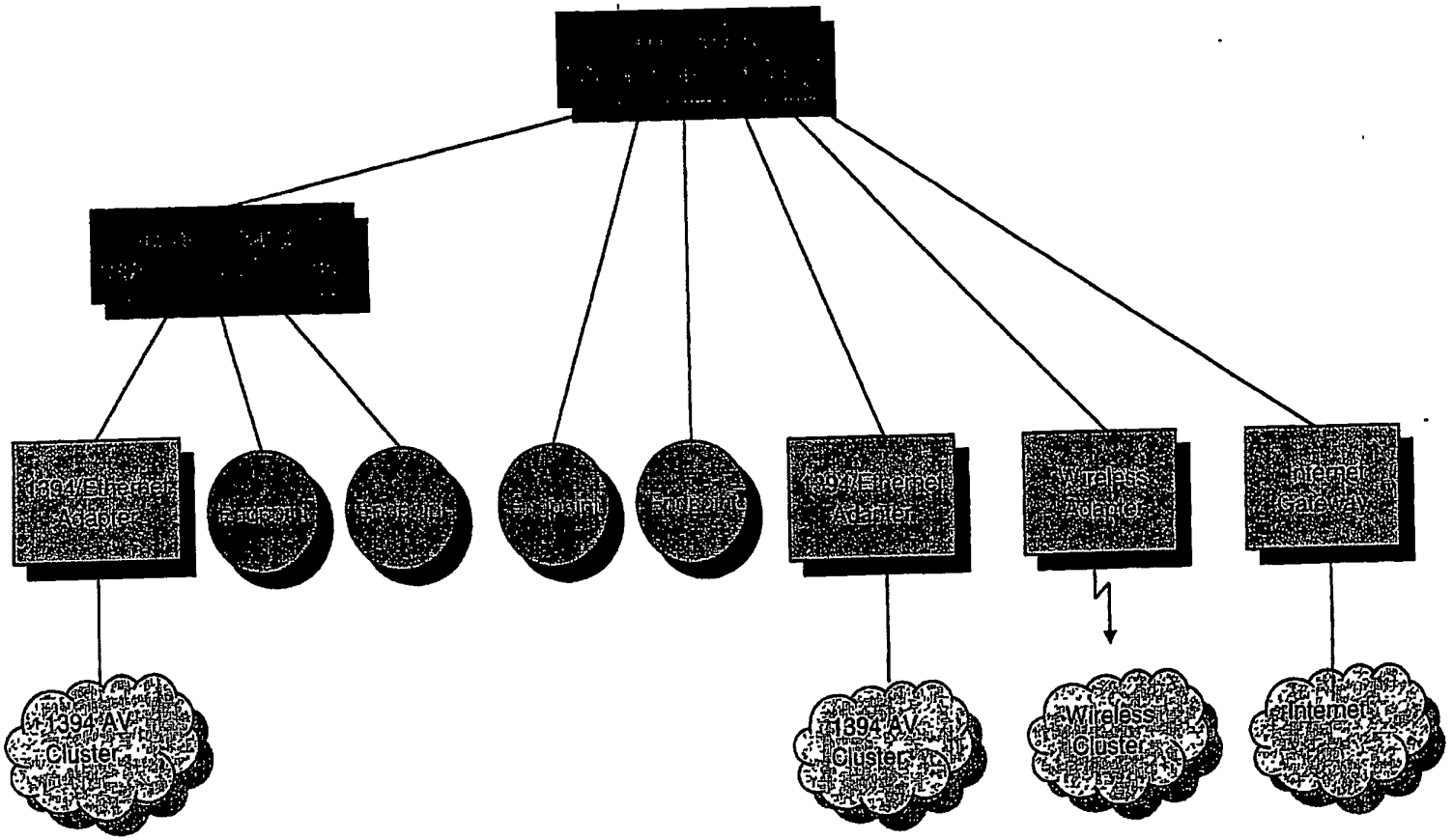
Example of Customer Upgrade (2)



Example of Customer Upgrade (3)



Example of Customer Upgrade (4)



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